Surgical Approaches to the Recurrent Laryngeal Nerve

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Abstract

During thyroid and parathyroid surgery, avoiding injury to the recurrent laryngeal nerve (RLN) is critical. Several general principles should be adhered to when performing these surgeries in order to protect the nerve. Visual identification and dissection of the RLN is now the standard technique for its preservation during thyroid surgery. Based on the pathology and indication for surgery, the optimal approach to the RLN, lateral, superior or inferior, should be utilized.

Keywords

Recurrent laryngeal nerve • Surgery • Dissection • Thyroidectomy • Remote access • Robotic thyroidectomy

Overall Approach

While several techniques for identifying the recurrent laryngeal nerve (RLN) are available to surgeons, the most fundamental question is whether risk of injury is minimized by nerve identification or avoidance. Historically, many surgeons adopted surgical approaches that were designed to avoid identification and dissection of the RLN [1]. These were premised on the belief that manipulation of the nerve was likely to lead to injury [2]. Additionally, it was thought that by

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performing strict capsular dissection the nerve would simply not be encountered during surgery. However, as discussed in other chapters, the anatomy of the nerve does not guarantee that avoidance will maintain its integrity.

Many studies have now confirmed that identification and visualization of RLN is the safest method for nerve management [3, 4].

Identification of the RLN is based on an expert knowledge of both normal and aberrant anatomy of the nerve and surrounding structures. Rather than a single structure dictating the location of the nerve, an understanding of a host of anatomical relationships (discussed in detail in other chapters) should be employed when seeking it. Until recently, dissection and identification were based on visual clues only. Many surgeons now promote the use of a nerve monitoring system to aid in initial localization of the RLN by "neural mapping."

General Principles

When dissecting the RLN, proper exposure during surgery is critical. To facilitate that, in cases of goiter, the strap muscles can be divided if retraction does not provide adequate exposure. To optimally reveal the region of the RLN, while retracting the strap muscles laterally, the laryngotracheal complex with the thyroid should be retracted ventromedially.

Blood may obscure visualization of the nerve, so a bloodless field is important for nerve identification. Despite meticulous attempts at hemostasis, bleeding, particularly from the area of the ligament of Berry, can occur during dissection or after extraction of the thyroid gland. This is best managed with careful, pinpoint bipolar cautery or clamping of specific sources of bleeding while fully visualizing the RLN. Blind clamping or cautery in the region of the RLN without direct nerve visualization exposes the nerve to injury.

Critically, when dissecting the nerve, no structure should be cut unless the position of the RLN is clearly understood. Strict adherence to this rule will reduce transection injuries to very low rates. While the nerve is traced, close attention should be paid to the degree of tension that is applied to the nerve. Excessive retraction of the thyroid gland can lead to a RLN traction injury [5]. As the gland is moved medially, the larynx can be displaced upwards, stretching the distal RLN and increasing the risk of neuronal dysfunction. One proposed technique for RLN identification, the palpation technique, exploits the tension that can be placed on the nerve [6]. In theory, this tension makes palpating the nerve easier. While plausible, use of this technique should be avoided because of the injury that might result from this tension.

Specific Techniques

While each patient demands a slightly different technique for management of the RLN, the methods for identifying and dissecting the nerve can be broadly divided into three approaches: lateral, superior, and inferior. Surgeons performing thyroid surgery should be familiar with all three techniques, as it cannot always be predicted when a specific approach may be required [7].

Lateral Approach

The lateral approach is the most commonly utilized RLN technique during routine open thyroidectomy. In this approach, the RLN is sought at the level of the middle of the thyroid lobe [8].

In the lateral approach, mobilizing the sternohyoid and sternothyroid muscles exposes the thyroid and central compartment. The strap muscles are retracted laterally exposing the carotid artery and jugular vein. The carotid artery is then carefully retracted laterally and the thyroid medially to access the paratracheal soft tissue. This is the general area where the RLN lies.

The inferior and superior thyroid poles are dissected and the vessels in those areas are managed appropriately. Dividing the middle thyroid vein facilitates retraction of the thyroid medially and improves exposure of the paratracheal region. To preserve the vascular supply to the inferior parathyroid gland, it is best to dissect the parathyroid from the inferior pole before retracting the lobe medially [9].

As noted earlier, a number of structures can act as approximate landmarks for seeking the

nerve, including the parathyroid glands, the tubercle of Zuckerkandl, the inferior thyroid artery, and the inferior edge of the inferior cornu of the thyroid cartilage. Using all of these structures as clues often leads to prompt identification of the RLN.

One significant benefit of the lateral approach is that the nerve is identified and dissected only in its last few distal centimeters prior to it passing deep to the inferior constrictor muscle. It avoids uncovering the nerve at the thoracic inlet and lower cervical region, thus allows for more limited RLN dissection. Additionally, avoiding dissection of the nerve in the lower cervical region aids in preserving the vascular supply to the inferior parathyroid gland.

This approach may not be suitable in some circumstances that limit exposure of the lateral thyroid region, such as with a large goiter or a well-developed tubercle of Zuckerkandl. The application of this approach in revision thyroid surgery is challenging because of dense scar tissue that often obscures the lateral thyroid region. In revision thyroidectomy, it is often easier to identify the RLN in an area which contains minimal scar tissue from the previous surgery. By working inferior to the plane of previous dissection, scar tissue can often be avoided.

Several other factors should be considered when utilizing the lateral approach. As the RLN is found rather distally in its course with this approach, extralaryngeal branching may have already occurred. One cannot simply assume that a nervous structure represents the entirety of the RLN and care must be taken that all branches of the nerve are identified and preserved. The unusual situation of a nonrecurrent laryngeal nerve also presents significant risk when using the lateral approach. Due to its aberrant course, often running almost perpendicular to its expected orientation, such a nerve can be easily overlooked and transected [10].

Superior Approach

The superior approach to the RLN can be challenging but invaluable in cases with large cervical or substernal goiters. Large glands prevent adequate retraction to expose the nerve in the regions seen with the lateral or inferior approaches. This technique can also be used if the RLN is not successfully found using one of the other approaches or in cases where there is a suspicion of a nonrecurrent laryngeal nerve. If performing remote access surgery using a retroauricular incision, the vector of approach to the thyroid is from superior to inferior. The superior approach for finding the RLN is consequently the evident technique in these cases.

In the superior approach, the superior pole of the gland is exposed and the pedicle is ligated. Particularly, in large goiters the external branch of the superior laryngeal nerve can extend inferiorly along the superior pole and as a result can be easily injured if care is not taken to protect it. After division, the superior pole is reflected in the ventral–lateral direction. This maneuver will expose the inferior constrictor muscle. At the inferior margin of this muscle, the ligament of Berry will be encountered. The RLN will be found in this area running under the inferior constrictor muscle. This is an advantage of the superior approach as the laryngeal entry point is the most constant anatomical site of the RLN. In addition to visual recognition, use of neuromonitoring can greatly aid in this approach.

While ideal in certain situations, the superior approach does present some challenges. Dissection at the fibrous ligament of Berry can be arduous as it bleeds easily and small amounts of blood can easily visually obstruct the field. As the RLN extends distally its caliber can decrease, causing it to be difficult to distinguish from adjacent small vessels. Also, surgeons must remember that this distal segment of the nerve is relatively fixed and consequently is particularly susceptible to stretch and neuropraxic injury. Care should be taken to avoid exerting excessive tension on the nerve either while dissecting or simply by overly retracting on the superior pole.

Inferior Approach

The inferior approach was popularized by Sedgwick and Lore in the 1970s [11, 12]. This technique was taught to many surgeons as the

standard approach for finding the RLN and can be used in most routine thyroidectomies. However in patients with large goiters, particularly if substernal, the inferior approach cannot be used due to an inability to expose the RLN triangle.

The RLN triangle is the key concept in the inferior approach. The RLN is sought in this inverted triangle, whose apex extends inferiorly toward the thoracic inlet [13]. The retracted inferior thyroid pole represents the base of the triangle, and the medial and lateral walls are formed by the trachea and the retracted strap muscles.

The bed of tissue in this area is soft and the RLN is not fixed in position (such as it is at the ligament of Berry). Both of these factors facilitate dissection of the nerve without injury. Further, the nerve in this area consists of a single trunk without branches and tends to have a larger diameter.

The inferior approach can be used routinely, however many surgeons now avoid it for several reasons. As the RLN is identified quite proximally along its course, a long segment of the nerve must be dissected to trace it to its entry into the larynx. This increased length of dissection may increase the risk of injury. Another potential disadvantage of this approach is the possibility of devascularization of the parathyroids, especially the inferior glands, due to the extensive dissection.

Revision thyroid surgery is an optimal situation for utilization of the inferior approach. As noted earlier, in patients who previously have undergone thyroidectomy the lateral approach is often not feasible due to extensive scarring and fibrosis. By seeking the nerve in an area inferior to the plane of the previous surgery, it can often be found without great difficulty.

Minimally Invasive and Remote Access Surgery

Over the last two decades a number of minimally invasive approaches to thyroid surgery have been described, the most popular of which is the video-assisted approach (MIVAT) described by Miccoli et al. [14]. More recently, remote access techniques, in which the incision is not placed on the anterior neck, have garnered significant attention [15, 16]. These procedures require surgeons to be familiar with approaches to the RLN that have slightly different vectors than those used in more conventional surgery.

During MIVAT, while viewed through an endoscope, the thyroid compartment is visualized in the same orientation as in conventional thyroidectomy. Consequently, the approach to the RLN is similar to the lateral approach. During these cases, in order to adequately expose the paratracheal area it is crucial to retract the thyroid not only in a medial but also in a ventral direction. By rotating the thyroid from its paratracheal location, the RLN can be identified just proximal and deep to the tubercle of Zuckerkandl. Dissection of the thyrotracheal groove is carried out using small atraumatic instruments under endoscopic magnification. This magnification provides excellent visualization of the nerve. After delivery of the gland through the incision, surgeons should pay particular attention to avoid excessive retraction, which potentially increases the risk of RLN stretch injury.

The approach to the RLN during remote access thyroid surgery is determined by where the incision is made. Using a retroauricular (or facelift) incision, the gland is encountered from above. As a result, the RLN is most successfully found using the superior approach. The superior pedicle is encountered and ligated. The superior pole is then retracted inferiorly and ventrally, exposing the area of the inferior constrictor muscle. Due to the orientation of this technique, after the nerve is found the area of the ligament of Berry is easily managed.

Another popular remote access technique, the transaxillary procedure, approaches the gland from an inferolateral direction. The gland is first mobilized by releasing the superior and inferior poles and the anterior surface of the trachea is exposed. The gland is then retracted medially. The RLN is sought and dissected in the tracheo-esophageal groove. The orientation when seeking the RLN in transaxillary thyroidectomy is quite different from traditional thyroid surgery. Rather

than visualizing and approaching the surgical bed in a ventral to dorsal trajectory, the RLN is sought in along a lateral to medial axis.

RLN Dissection Tips and Pitfalls

There is no replacement for clinical experience and expert knowledge of the surgical anatomy. However, the following tips can help facilitate safe identification and dissection of the RLN [9]:

- As noted above, applying the simple rule of not cutting any structure when dissecting the nerve until its course is fully identified will reduce permanent nerve injury rates to a minimum. If tracing the nerve visually, the nerve must be in full view when dividing overlying tissue. If neuromonitoring is being used to guide dissection, tissue must be stimulated and provide a negative response before transection.
- After the RLN is identified, only the minimal amount of dissection of the nerve necessary to complete the surgery should be performed. Any dissection around the nerve needed to expose and reveal its course is appropriate. However once this is achieved, any extraneous dissection should be avoided.
- Great care should be taken when retracting the gland medially as the RLN is traced distally. Tension placed on the thyroid can be transferred to the RLN, particularly by the fibrous attachments of the ligament of Berry. As tissue attachments to the thyroid are released the same amount of force is distributed over a narrower area, increasing the tension placed on these tissues. It is critical to avoid excessive tension to prevent a neuropraxic injury of the nerve. With retraction, pressure can also be applied to the nerve by a blood vessel bowstringing across it.
- The RLN always divides ultimately into at least a single anterior and single posterior branch [17]. However the branching pattern can be markedly more complex, including multiple anterior or sensory branches [18]. Consequently, surgeons must be certain that they are tracing the anterior branch of the nerve and that additional motor branches are not being overlooked. Mistakenly following the posterior branch of the nerve can result in inadvertent transection of the crucial anterior branch. If an anterior branch has a small caliber, one must be suspicious that it represents just one of the elements of motor division of the RLN. In this situation, retrograde dissection can be performed to exclude proximal branching.
- Small caliber nerves or those enmeshed in the ligament of Berry have a higher risk of injury. If the RLN is at high risk of injury, a small part of normal thyroid tissue (away from cancer margins if present) may be left at the point of nerve entry to avoid damage [9].
- Any form of cautery should be applied cautiously when working within a close proximity to the nerve. It is common after gland removal to have small sources of bleeding, particularly in the area of the ligament of Berry. Hemostasis must be achieved without exposing the RLN to risk of excessive thermal trauma. Bipolar cautery, which can be delivered precisely with a fine jeweler's forceps and should be activated only transiently, is the optimal device for hemostasis in the region of the nerve.
- While dissecting the nerve, if a parathyroid gland that is closely adherent to the thyroid capsule is encountered, then preservation of the gland with an adequate blood supply should be attempted. However, if this is prohibitively difficult and puts the nerve at risk, the gland should be removed and then autotransplanted. It should be remembered that preservation of the RLN is paramount.
- Large goiters, especially if substernal, can stretch the RLN, which may be redundant after extraction of the enlarged gland. Lack of attention to the nerve at its distal segment after thyroid gland extraction can lead to injury. Therefore in these cases, the nerve should be identified up to the point where it enters the larynx.
- Aggressive suctioning or vigorous use of peanuts or gauze during nerve dissection can injure the nerve, so this should be minimized.
- The anterior arch of the cricoid cartilage serves as an important landmark in thyroidectomy. The RLN enters the larynx just deep to

the inferior constrictor muscle, which rests on the cricoid cartilage. After this point, the nerve is within the larynx and no longer in the surgical field.

- The cricothyroid muscle should be dissected cautiously, as cautery of the ventral surface of the muscle can lead to injury and laryngeal dysfunction postoperatively.

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